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**PHYSIOLOGICAL AND MEDICAL CONSIDERATIONS
OF THE US ARMY PHYSICAL READINESS TRAINING PROGRAM**

by

DARYL ZAPATA, BA
and
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DIVISION OF OCULAR HAZARDS

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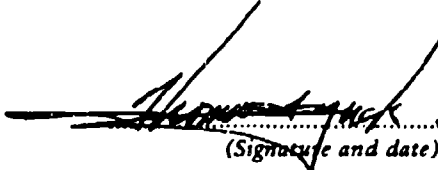
**Physiological and Medical Considerations of the US Army Physical
Readiness Training Program--Zapata and Stamper**

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ABSTRACT

↙ The literature concerning the biomedical factors related to the incidence of overuse injuries which occur during Army Initial Entry Training revealed that overuse injuries in male soldiers reached nearly 26 percent and in females soldiers reached 62 percent. The average amount of time lost for these injuries was 13 days. Underlying strength factors in many military jobs demand exercises to develop upper and/or lower body dynamic, static, and explosive strength. Methods and principles must include diet to match energy requirements, adequate sleep and rest, general conditioning preceding specific training (which fits activity the soldier will be expected to perform), and responsibilities of commanders to establish realistic goals and methods for attaining those goals. Based on the review of the literature we anticipate that overuse injuries will be decreased and overall combat fitness will be increased if physical training programs combine work physiology principles with logistic practicality, physical training practices, integrate all components harmoniously, and all participants and training personnel practice the principles accurately/consistently. A prototype controlled study should be conducted to substantiate these recommendations and to determine the specific pace persons should be expected to keep in basic training, the Army Physical Readiness Training Program, and other physical training programs.

PREFACE

Mr. Zapata's participation in this project was made possible as part of the US Army's summer associate program that was instituted under the supervision of the Battelle Memorial Institute. The authors wish to thank Mr. Jim Larsen of TRADOC for his valuable assistance in accumulating information used in the preparation of this report. We wish to also thank Colonel John Moore of Letterman Army Medical Center for his comments made during the review of this manuscript. We also wish to thank our Technical Editor, Lottie Applowhite, for her editorial review of this manuscript.

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EXECUTIVE SUMMARY

**US ARMY PHYSICAL READINESS
TRAINING PROGRAM:
RECOMMENDATIONS FOR
UNIT TRAINING**

by

Daryl Zapata, BA

and

David A. Stamper, MA

EXECUTIVE SUMMARY

In response to a request from the Director of Unit Training to The Surgeon General, United States Army to recommend what exercise schedule would be the most effective in terms of maximum muscle development and injury prevention during Initial Entry Training, we are submitting the following recommendations and supporting these recommendations with research findings cited in the indexed literature. Our recommendations are presented under the headings Work Principles, Methods for Implementing the Principles, and Conclusions.

RECOMMENDATIONS FOR UNIT TRAINING

WORK PRINCIPLES

The guidelines for conducting physical readiness training (PRT) in the United States Army are contained in FM 21-20. Astrand and Rodahl(1970) summarized principles of work physiology. We have expanded on their list based on our experience and findings. The principles we recommend are:

<u>Principle</u>	<u>Comment</u>
● Goals are realistic and measureable for individual/group.	● Goals (i.e., training capacity) will be reflected in the past fitness history and present fitness level of each soldier. Resources are cost accountable (e.g., reduced incidences of medical disease

Recommendations, continued

<u>Principle</u>	<u>Comment</u>
	states and improved good health, manpower hours saved because of optimal training methods have precluded stress fractures, exhaustion, exposure, and other medical problems).
● Training cycle is continuous/progressive.	● To provide the necessary stimulus for increased fitness, training must be continuous and progressive.
● Specific training fits activity to be performed.	● Repeated correct practice of activity (perhaps simulated) insures maximum benefit. Imperfect practice leads to an imperfect skill.
● General training precedes specific training.	● Endurance activities which develop cardiovascular and respiratory capacity and are performed at submaximal heart rates should be performed several times a week. Development of muscular

Recommendations, continued

<u>Principle</u>	<u>Comment</u>
	strength in the large muscle groups, especially in the back and postural muscles precede the training of specific physiologic systems. Anerobic capacity may be developed by performing high intensity activities for one minute, followed by a three or four minutes of rest between each of four or five repetitions.
● Nutrition (dietary requirements) should match energy requirements.	● Present mess practices indicate sufficient caloric intake and adequately balanced meals are available for the male recruit. During basic training and other stressful periods foods high in iron and calcium may be required for female recruits to prevent anemia and bone stress injuries. When field training is combined with extensive physical training frequent high carbohydrate feeding may postpone exhaustion. Weight

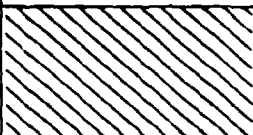
Recommendations, continued

<u>Principle</u>	<u>Comment</u>
	loss should be restricted to no more than one to two pounds/week; amounts greater than this are usually associated with loss of lean body mass and water.
● Adequate sleep and rest periods will optimize physical development.	● The sudden introduction of a physically demanding training cycle places great demands on the adaptive mechanisms of the body. During initial entry training, regular periods of sleep, eating, physical training, and rest will assist these adaptive mechanisms. Training should remain constant (i.e., duration and/or intensity) within two or three week cycles (Table 1).

METHODS FOR IMPLEMENTING THE PRINCIPLES

● The commander will ... Establish the goals/objectives;	● Based on the climate, terrain, and facilities that are present during each training cycle the
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TABLE 1 PHYSICAL TRAINING SCHEDULE

		Weeks							
		Cycle 1			Cycle 2		Cycle 3		Final Week
		1	2	3	4	5	6	7	8
Stamina (Aerobic Training)	Lower Body Dynamic Strength	PT Walk 30 min with pack, increase 1-2 lb/day up to 25 lb			Performed in running shoes with gradual use of boots beginning after the third week				
					ALTERNATE ↓ Walk/run 30 min performed in running shoes				
Muscle Strength Development	Upper Body Dynamic Strength	Pull Ups (Timed) Wheelbarrow Race Rifle Exercises Load/unload AMMO Boxes or Sand Bags							
	Upper Body Static Strength	Isometric Rifle Exercises Log drills eg, Pivot Circle							
	Lower Body Static Strength	Log Drills eg, Half Knee Bends							
	Upper Body Explosive Strength	Log Drills eg. Overhead Toss Medicine Ball							
	Lower Body Explosive Strength	20 yd Shuttle Run 60 m Line Relay							
	Trunk Strength	Leg Lifts Leg Spreader Squat Thrust							

Recommendations, continued

<u>Principle</u>	<u>Comment</u>
Provide methodology for attaining goals; and Make certain all personnel are aware of purposes and principles underlying the training program.	local commander will establish the goals and objectives for basic training and the methodology for attaining these goals.
● The general guidelines are... In the first three weeks strength and stamina should be developed.	● During the first three weeks, while the soldier physiologically begins to adapt to Army life, general conditioning methods should be followed. Physical training will be comprised of short runs (in running shoes), walking/marching, and military drills. The physical training "run" during this first three weeks should be a brisk-paced walk/march similar to that performed by the Israel Defense Forces. Strength and stamina should be increased by using the exercises that are related to the performance of the most strenuous MOSs. These exercises increase

Recommendations, continued

Principle

Comment

● During the remaining weeks, physical training increases in duration and/or intensity.

● Proper footwear is essential.

static, dynamic, Recommendations, continued and explosive strength for the upper and lower body as well-as stamina.

● During these two-week cycles, each week should include four training days. One day, soldiers will participate in physical training of long duration or high intensity physical work; but the following day they will participate in a program of medium to short duration or a program with medium to low intensity work. The brisk-paced walk/march can now be alternated with a 30-minute walk/run that will gradually be comprised entirely of running.

● During the first three weeks the running shoe should be worn as often as possible with a gradual transition to the use of the combat boot. All PT runs should be

Recommendations, continued

Principle

Comment

performed in running shoes. The walk/march while initially performed in running shoes can gradually be performed in combat boots, especially as the weight carried by the soldier is increased. A newly designed boot incorporating a more cushioned midsole, a stiffer shank, but flexible sole in the region of the forefoot metatarsal junction should be available. A short-term solution to the shock absorbency problem could include the placement of a sorbothane heel pad in each boot.

CONCLUSIONS TO RECOMMENDATIONS

The United States Army Physical Readiness Training Program and other physical training programs beginning with Initial Entry must ...

- Combine work physiology principles and practices with logistic practicality.

- Adhere to physical training principles which integrate all components harmoniously.

- Demand that all participants and training personnel practice the principles accurately/consistently.

REFERENCE

Astrand P, Rodahl K. Textbook of work physiology. New York: McGraw-Hill Book Co., 1970.

**PHYSIOLOGICAL AND MEDICAL
CONSIDERATIONS OF THE
ARMY PHYSICAL READINESS
TRAINING PROGRAM**

*Summary of Research Findings in
Indexed Literature*

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and

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Physiological and Medical Considerations of the U.S. Army Physical Readiness Training Program-Zapata and Stamper

INTRODUCTION

During the eight weeks of basic training the task given to the cadre of a basic training company is to (1) take a relatively inactive group of civilian men and women and increase their overall level of physical fitness and (2) teach them the basic military skills required of all soldiers. To assess the relative success of their work, the Army has relied on results from the basic "physical readiness training" (PRT) and skills qualifications tests (SQT). Much of the daily physical training is directed toward successful completion of the PRT test which has changed in content through the years. However, there is little evidence which equates a good score on the PRT test (i.e., pushups, situps, and the two-mile run) with fitness for combat.

This review of physical readiness training has been prepared at the request of the US Army Training and Doctrine Command to determine if sufficient data exist to provide recommendations on physical readiness training to individuals within the military medical community, active duties studies, or in the recently much studied area of sports physiology and medicine.

It is anticipated that the application of established principles of physical conditioning during initial entry physical training will lead to the reduction of the disturbing and cost-inefficient high incidence of lower extremity injuries during basic training. This

report encompasses those injuries over which the Army training may influence some control. It does not refer specifically to injuries of accidental nature, although the recommendations may have a secondary impact on prevention of accidents associated with increased fatigue during periods of stress.

Bone, ligament, tendon, muscle, or even skin exhibit signs of stress or overuse following repeated submaximal periods of exercise. In general terms, these may be considered "wear-and-tear" injuries. Several military studies have documented the incidence and loss in training time and lack of physical fitness due to lower extremity stress injury in recruit training (1-6). Kowal (2) reported that the incidence of overuse injuries in new recruits was as high as 26 percent for men and 62 percent for women. The average loss of work time for the women was 13 days.

Included as overuse injuries of the lower extremities are stress fractures (i.e., pelvis, femur, tibia, calcaneus, and metatarsals), and knee injuries including chondromalacia. Also reported are incidences of achilles tendinitis, plantar fasciitis, anterior compartment syndrome, and other leg muscle strains (1-7). With the introduction of more women into basic training units the number of injuries has risen significantly (2,4). These injuries adversely affect the Army's achievement of the goals of basic training as well as the health and performance of the recruit. The immediate effect of incurring an overuse injury of the lower extremity is a reduction, if not cessation, in the recruit's ability to train and perform at the

previously achieved level, without possibly adverse consequences (8).

Overuse symptoms may appear upon exceeding a particular number of repetitions of a certain loading force, or upon exceeding a particular maximal force during repetitive physical loading (1,2,4). It must be emphasized that there is considerable variability among individuals as to the exact number of stress cycles or the maximal force required to produce failure at a particular body site (1,9). However, in several military studies (1,2,4,5) it was reported that the onset of these injuries occurred during the third week of basic training. It was this observation which lead to one attempt to reduce injuries by eliminating PRT during the third week. This radical approach deviates from accepted principles of a physical training cycle discussed below which state that training should be continuous and progressive.

The early literature (5) and the most recent (1-4,6,7,') have implicated several causative factors in stress injuries, but specific injuries as yet have not been correlated with singular causes. Causative factors include obesity, low physical fitness aptitude upon initial entry, previous injury, physical anomalies, wider pelvis and greater flexibility in women, footwear, training surfaces, and training techniques. Since the 1975 addition of women to the basic training regimen there has been an alarming increase in the incidence of stress injuries. Women had 2.35 and 2.13 times the incidence of stress injuries as men in two basic training studies (2,4). Where previously stress fractures and other overuse injuries may have been considered occupational hazards of the military, the present rate of

injury is considered a problem.

Further, with the change in AR 30-15 which now requires all military personnel to complete an annual PRT test composed of a two-mile run, pushups, and situps, the problems associated with reconditioning a much older soldier are now being seen in orthopedics clinics at the Army medical centers. Career officers and senior noncommissioned officers (NCOs) must now meet newer more demanding standards on the PRT test. The role of physical training in the Army must extend from the new recruit, to career officers and senior NCOs, and the goals and problems associated with each are different.

INITIAL ENTRY TRAINING

Philosophy. Upon entry into the Army recruit training is directed toward "Unit Physical Readiness (UPR)" (10). The elements of UPR are to (1) develop strength and endurance to sustain activity over a long period of time; (2) develop muscle tone adequate to maintain posture and reasonable weight control; (3) develop proficiency in military physical skills essential to personal safety and effective combat performance; and (4) instill characteristic traits beneficial to accomplishments of military missions, which include confidence, aggressiveness, reaction under pressure, and teamwork.

Physical Training Goals. To assess the effectiveness of physical readiness training, and to provide motivation for PRT, the Army physical readiness test ("APRT") is given to all basic trainees during the last week of basic training (10). The PRT test presently includes

the number of pushups and situps done in a two-minute period followed by a timed two-mile run. However, the only results placed in each soldier's record is a simple pass/fail, not the actual score.

The performance factors underlying these three tests predominantly include aerobic power and local muscle endurance, factors which must be considered questionable if we ask the question, "Have these soldiers received the proper physical training to be combat ready?" Present warfare concepts envision military troops performing endurance type tasks over a period of several days with very little sleep. Task specific (or more appropriately MOS specific) physical performance requirements vary from very intense in the case of the tank crews and light infantry, to light in jobs such as those involving clerical activities. The likelihood of troops being required to run for a distance of 1-2 miles at a fast pace and fight seems remote. Rather, as in Granada, endurance marches followed by periods of combat which dictates aerobic endurance performance with MOS specific strength/skill training should be at the base of an initial entry physical training program.

Recruit Population. Prior to 1975, the population of the United States Army basic training units consisted of men, ages 17 to 35 years. Even within this relatively homogeneous population there occurred a wide range of morphological differences (e.g., height, body composition) and physical fitness characteristics (e.g., muscle strength, cardiopulmonary endurance) as well as differences in athletic and/or physical work experience. The effect of the total

physical training during the initial entry period was to produce a population of soldiers that met a stringent standard of physical aptitude as measured by a five-part PT test.

Since 1975 the basic training graduation standards for the APRT have been modified. Test scores are now adjusted according to age categories for both men and women, with the women's performance requirements lower than those for men at all age levels. Since a simple pass/fail score is entered into the soldier's record there is little incentive to do more than just meet the minimum number of repetitions or time that is required. Also, in the case of the most fit soldiers there is an upper limit where additional points are not given for continued performance.

Physical Training Methods. Individual commanders at each of the Army's Initial Entry Training Centers for basic training are responsible for the methods, time blocks, support required in equipment, areas, instructors, transportation, and training schedules necessary to accomplish the basic training goals. The methodology for uniform physical readiness training is prescribed in Field Manual 21-20 (10). PRT involves a series of progressive calisthenic exercises designed to "exercise all major muscle groups and develop strength, endurance, coordination, and flexibility" (10), and includes a run of between three-quarters mile and four miles. The PRT frequency is five to six days per week and varies in duration from fifteen minutes to one hour. The PRT intensity varies, depending on the type of exercise and duration of its performance.

Since basic training involves road marching, drill and ceremony, and other military training activities unfamiliar to initial entry recruits, it is important to include these activities in any consideration of total physical training. Recruits in basic training are expected to be physically prepared for "extensive road marches and military training activities" over an average day of about 16 hours (11). It may be expected that the various basic training centers in the United States may have somewhat different physical training programs, depending on personnel, location, facilities, terrain, and environmental conditions. Other factors that are controllable and affect the recruit in training are the nutritional intake and sleep/rest cycles. The training programs of the individual basic training centers have been instituted by directive and by historical trial-and-error methods that have met the needs of the Army consistent with the philosophy and goals of the specific initial entry training center (IETC).

At present, the measure of the effectiveness of the IETC total physical training program is the score each recruit achieves on the PRT test before graduation from basic training. However, despite increases in the number of pushups, situps, and improved times for the two-mile run, no significant improvement in tests of strength have been demonstrated by troops at the conclusion of basic training (11-13). This finding, in addition to the high incidences of overuse injuries, suggests that somewhere in the application of the principles and training procedures outlined in the physical training manual

emphasis of the correct training practices are not being followed.

Footwear. Any consideration of total physical readiness training methods in basic training must include the equipment worn by the recruit. Physical demands on Army personnel require extensive use of the lower extremities in addition to the upper body. Problems related to the type of footwear used during training require thorough consideration. No other single piece of equipment can so adversely influence physical training as the type of footwear that is used.

The uniform of the day for basic trainees is the battle dress uniform (BDU) which includes combat boots, except when performing physical readiness training. Physical training produces adaptive responses in the recruits that are specific and, at the same time, general for the function practiced. Since marching, drilling, and other military exercises are carried out in boots, practice of those skills should be done for a reasonable time period in boots.

Physical readiness training, which is separate from other training, serves a different purpose-- it is designed to develop general physical fitness qualities of strength, speed, and endurance. For physical fitness activities, especially running, since 1982 the Army directed troops to wear athletic shoes during physical readiness training. It is especially important during basic training that recruits have optimal development of the general qualities of physical readiness required to continue on to the development of the specific military physical skills in subsequent training. Wearing of boots in PRT is not advantageous for attaining optimal physical development. A

large volume of literature (1,2,4-7) implicates the wearing of boots with stress or overuse injuries of the lower extremities. Currently under study (7) are methods for improvement and design of combat boots which will reduce the incidence of injury to men and women.

Male/Female Performance Sex Differences. The present U.S. Army slogan states "Be all that you can be." Basic training graduates must have the physical ability, as measured by physical performance standards in the PRT test, to perform their jobs as they continue with the Army. Their job requirements following basic training may not require the development of maximum potential physical performance.

A review of the literature available on male and female quantifiable differences in sports performances (11,14) lends some insight as to what physical performance levels may be expected of women relative to men. When world records in swimming sprints, (raw upper body power) or track events from sprints through the marathon (lower body power and aerobic ability) are compared, adult women's performances are approximately 80 to 90 percent of adult men's. It may be inferred that there is a 10 to 20 percent difference in male and female sports performance due to the innate biological sex limitations suggested by physiologists (14,15). Among other factors, males have higher levels of testosterone, which promotes muscle mass development, and females have higher levels of estrogen, which promotes fat deposition. In the 13-to-22-year age group, percent body fat for males is 12 to 16 percent and for females is 22 to 26 percent (14). Average female bodies are smaller in size than males, and this

results in a smaller heart size and stroke volume. Lower female blood hemoglobin concentration, higher body fat percent (and lower lean muscle mass), and the lower stroke volume contribute to the reduced aerobic endurance performance relative to male performance. Structural differences in a wider pelvis and differential areas of fat deposition among females compared to males may give preferential biomechanical advantage to males for weight-bearing activities. Whether or not such physiological sex limitations may be relevant to Army basic training should be the subject of future research.

Presently it can be inferred that total physical training during basic training under the ideal conditions experienced by world-class athletes could at best produce female physical fitness performance scores between 80 to 90 percent of those of the male recruits. Several studies of military physical training of females and males state that female fitness deficiencies are due partially to social factors which may be overcome (6,11,12,14,16-18), as well as to the innate biological sex differences mentioned above. Female physiological and biochemical responses to fitness training in terms of cellular mechanisms are the same as in the male (14,17). Strength or endurance differences among a population are multifactorial; sexual identity is only one of the factors involved in ability to adapt to physical training. Lenz (17) reported that when the initial performance differences between males and females were accounted for, the rates of increase in performance were the same for males and females.

Protzman's evaluation (11) of the first women admitted to the U.S. Military Academy, West Point, and their male classmates revealed a distribution of Physical Aptitude Examination scores between 200 and 850 on initial entry to the first eight-week summer training period. While 81 percent of the women scored between 200 and 400 points, 68 percent of the men scored between 550 and 850 points. Overlap of scores for men and women occurred between 400 and 550 points, and included 32 percent and 19 percent respectively. Current Army policy is to integrate male and female noncombat training wherever possible. Therefore, training in today's Army must encompass a recruit population with a range of physical aptitudes wider than ever before in the history of the U.S. Army.

In actual practice, the U.S. Army total physical training must account for differences among new recruits with a range of physical aptitudes as well as physical abilities or potential capacities, regardless of sex. The goal of basic training in physical readiness is to increase the physical performance of the recruit to reach an acceptable minimum standard, and to establish a physical training attitude and routine among all soldiers.

Initial Entry Training in Today's Army

Recruits arriving for initial entry training include persons ranging from a high level of physical fitness to relatively sedentary life styles. The Army's tradition of maintaining group cohesiveness has always called for the pushing of the less fit to "keep up" with the group. However, the result has in reality kept the most fit at

the same level of physical fitness, or worse yet, allowed them to become less fit by not providing them with a sufficiently intense level of physical training and has encouraged the less fit to push beyond the limits required for the optimum training results.

The success of PRT in the IET process has been affected adversely by constraints placed upon the cadre of the training companies. The amount of time which each soldier must spend developing the basic skills necessary for every soldier are established by directive and recently the time constraints have been tightened by policy changes concerning the handling of IET soldiers. For example, it is now required that all trainees must receive eight hours sleep a night. Previously, when it was asked, "When can we possibly do this?", the reply was, "What are you doing between 0300 and 0500 hrs?" Additionally, where it was previously accepted that an NCO or officer could encourage trainees to eat their meals rapidly and leave the messhall, all troops are now given adequate time to eat their meals. While it is recognized that such changes are in the best interest of maintaining good health habits, there have not been allowances for the loss of time such changes have taken from the busy training schedule. The senior NCO who is faced with having his company at the rifle range 30 minutes following the lunch meal has only one solution to the problem, doubletime. This is in contradiction to principles outlined FM 21-20 which states that soldiers should not be run 30 minutes before a meal and 60 minutes following a meal. This situation would also be in contradiction to

the principle "train don't strain". For a soldier to run, even slowly, immediately following a lunch meal, wearing a helmet, rain poncho, water bottle, combat boots, and carrying a rifle-- all of which adds 20 to 25 lb (9 to 11 kg) to their weight-- adds to the overuse problem. Given these time constraints, the cadre will do the best job possible, but it may not be sufficient.

FM 21-20 outlines a variety of physical training exercises that are intended to provide overall fitness and maintain interest. However, given a limited amount of time the most efficient method of providing PT is to use five variations of the basic reveille exercises. These five exercises would probably include pushups, situps, squat thrusts, side straddle hop, and the two-mile run. Such an approach leads to high scores on the PRT, but in terms of total fitness and maintaining interest in physical conditioning, this approach violates several of the assumptions noted below under the principles of a physical conditioning program.

IET teaches the basic military skills required for all soldiers and the physical training part of IET emphasizes training the physical attributes required for military occupations. Myers, Gehardt, and Fleishman (19) performed an extensive analysis of physical performance standards required for Army jobs and identified five critical physical abilities that were basic to a wide variety of MOSs. Three of the five were further divided into upper or lower body requirements. The eight abilities were: (1) upper body static strength- e.g., hold a bag of cement, (2) lower body static strength- e.g., stand from crouched

position with a 30-lb (13.6 kg) package, (3) upper body dynamic strength- e.g., dig a trench, (4) lower body dynamic strength- e.g., walk up hill with a fire hose, (5) upper body explosive strength- e.g., open a window, (6) lower body explosive strength- e.g., jump over a four-foot wall, (7) trunk strength- e.g., lay carpeting, and (8) stamina-e.g., mow a large lawn. It is our opinion that a steady diet of the basic five PT training exercises does not nearly encompass these critical physical abilities. Initial Entry Physical Training must be directed toward this end.

RECOMMENDATIONS

The difficulty of control over a wide range of causative factors may preclude the eventuality of conclusive research studies on military injury cause and effect relationships. There have been anecdotal reports presented in the injury studies (1,4) where decreased incidence of stress-related injuries at some basic training centers have followed trial-and-error changes. The Army can continue to leave the problem of overuse injury to the commanders of the individual basic training centers or can begin to reduce overuse injuries by using an approach which follows proven physical conditioning concepts, principles, and guidelines.

Any set of recommendations which encompasses a subject as large as the U.S. Army physical readiness training program must effectively combine work physiology principles and practice with logistical practicality which would be available to local commanders within one of the world's largest institutions in number of personnel and domain served. It is expected that instituting these recommendations and any changes will involve accurate adherence to physical training principles.

General Principles of a Physical Training Cycle (20-22). FM 21-20 contains guidelines for the conduct of PT. The guidelines described in this report are based on sound principles of physical conditioning and, if correctly implemented, should yield soldiers with overall improved levels of physical fitness who will be prepared for additional physical conditioning required for combat fitness.

However, several areas exist where emphasis and clarification may be needed. First, every PT program which attempts to establish a cycle of optimal physical training must include some basic physiological and psychological principles, and these principles apply to initial entry military recruits, career military personnel, civilian personnel, career athletes. Astrand and Rodahl (22) have summarized these work physiology principles in their text.

1. Realistic, measurable goals should be established for both the group and the individuals. This provides psychological motivation and insures that the time and energy involved in training is cost-accountable (in dollars, cardiac accidents prevented, and personnel in good health).

2. The training cycle must be continuous and progressive. Training effects appear upon stimulation, but also disappear or are reduced upon discontinuation of training. Without progression in the training work load, there may be inadequate stimulus for further development.

3. Training must be designed specifically to fit the activity to be performed. Only repeated correct practice insures maximum benefit from training. Incorrect practice of a skill, regardless of the number of repetitions, makes for an imperfect skill.

4. Physical training capacity is related to the individual's present fitness level and prior fitness history. Although larger individuals may have larger physical work capacities due to larger muscle mass, individuals of any size can generally increase their

physical capacities. Few individuals can be considered to be at their ultimate level of physical conditioning.

5. A period of general training of the physiological systems should take place prior to a period of specific training. These general systems include:

(a) Development of the cardiopulmonary system and local muscle groups for long-term endurance activities which require transport and utilization of oxygen with body energy stores to produce muscular work (aerobic metabolism). Development of the cardiopulmonary system can be accomplished by exercising large muscle groups for 30 minutes or more at submaximal heart rate intensity, several times per week. Walking, marching, and jogging until only mildly fatigued; high repetition (20 or more) push-ups, sit-ups, and other upper body exercises until mildly fatigued develop aerobic endurance. Reveille exercises as prescribed in current basic training are mainly local muscle aerobic endurance exercises, not strengthening exercises, except for those soldiers with relatively low strength fitness characteristics.

(b) Development of muscular strength, especially in the back and abdominal postural muscles. Short duration, high intensity (greater than $1/3$ maximum load) work of 5 to 10 repetitions with rest intervals, several times per week will increase muscular strength. Examples of such exercises include sit-ups with added weight carried behind the head such that a maximum of 20 repetitions may be carried out before becoming fatigued, and walking with gradually increased pack loads, can develop postural strength.

(c) Development of joint mobility and metabolism of the articular cartilage. Repeated, regular activity increases the flexibility and metabolism of the joints and cartilage affected by the specific exercises.

(d) Stimulation of low-caloric consuming individuals to increase metabolism through regular exercise to become high-caloric consumers to improve work capacity. The physical training program provides the stimulus for this development.

6. The specific training cycle of the physiological systems should follow the general training cycle.

(a) Muscle, tendon, and ligament strength may be developed by activity of high intensity (greater than one-third of maximum load), of short duration (a few seconds) of 5 to 10 repetitions with short rest interval between each, and a frequency of several sessions each week (e.g. a circuit of exercises with variable weights should be developed for strengthening specific muscle groups for military activities, much like use of an obstacle course described in section 8-7 of FM 21-20).

(b) Aerobic power may be developed by performing activities at 60 to 80 percent of maximum heart rate intensity for 3 to 5 minutes (interval training). A rest or light activity interval is given between each of 3 to 5 repetitions at the higher work load level. These aerobic conditioning sessions could be performed twice each week (e.g. during physical fitness training 3 repetitions of a half-mile distance could be run at steady speed with equal duration jogging or

walking between each run. This activity should be performed before training for anaerobic capacity, described below, has been initiated).

(c) Anaerobic capacity may be increased by high intensity activity of 1 minute duration with 3 to 4 minute rest or light activity interval between each of 4 to 5 repetitions. This activity should be performed 1 or 2 times each week and should be conducted one to two months immediately preceeding the high intensity objective of the training period. (e.g. In preparation for such commando-type operations as the Grenade exercise repeated runs of a specifically designed obstacle course could be used once or twice each week over the month period prior to an expected target date.) It is not recommended for initial entry or relatively unfit populations.

(d) Aerobic endurance may be developed by submaximal intensity (120 to 140 beats per minute heart rate), 30 minutes or more duration activity, and a frequency of several sessions (2 or 3) each week.

(e) To achieve the best results a physical training program must integrate the above mentioned components for harmonious development according to the requirements of the activity for which training is done. This training program must also recognize that all positive adaptive change in the individual will occur gradually and is a function of the growth of the human body.

Application of General and Specific Training Principles to Initial Entry Level Training. Current Army practices and some of the problems that initiated this review of basic training have been summarized. The physiological principles that serve as a basis for general and

specific physical training have been summarized. The remainder of the recommendations for basic training physical readiness are suggested methods for instituting the principles previously discussed.

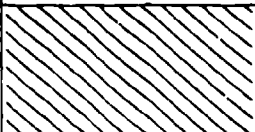
1. The commander of each basic training center is responsible for interpreting the Army's philosophy. The commander will establish goals and objectives for basic training and provide the methodology for the attainment of these goal.

2. All training personnel, medical and other support staff must be made aware of the purposes and principles of the program described below and the training or environmental factors which could lead to overuse injuries or environmental conditions which may produce other medical problems. The application of a physical training program is dependent to a great extent upon the conditions of weather, terrain, and facilities available during each training cycle. Such environmental and logistic factors vary widely depending on where the soldiers are stationed (e.g. Ft. Knox, KY in January or Ft. Bliss, TX in August). Therefore, each basic training center commander should refer to the appropriate guidelines for alteration of the training program during extremes of heat, humidity, cold, and other inclement weather conditions (23). Generally, any wide variation from temperate weather conditions places tremendous demands on the recruit's adaptive mechanisms involved in physical training and acclimatization. Since IRT is intended to begin the adaptation process to environmental stresses for future training or combat, the exposure time to these stresses should be gradually introduced with physical training.

3. Physical training of general physiological systems and skills to develop strength and stamina should comprise the first 3 weeks of IET. During the first three weeks of IET when the physical and psychological demands of Army life have begun, a general conditioning response of the body to these demands (e.g., PT, short runs, walking, marching, and military drills) will occur. Table 1 presents a generalized format describing suggested PT activities for IET. These activities are meant to be a representative sampling of possible activities and not an exhaustive list. With the exception of the "PT Walk," most of the PT activities are adequately described in FM 21-20. The strength and stamina factors presented in this table are those described by Myers et al (19) as being those physical activities used most often by the Army's most demanding MOS's.

(a) During the first three weeks, to eliminate the lower limb overuse problems, the PT run which has been performed during PRT should be replaced with brisked paced walking with a progressively increased weight load. The Israel Defense Forces (IDF) have found this walk to be highly successful in conditioning their soldiers without a significant incidence of lower limb overuse injuries (24). Traditionally, to elicit a training response the intensity of physical training activities has been accomplished by increasing speed, duration, or slope for each activity. A fourth variable to elicit a training effect can be achieved if the weightload is progressively increased (e.g., backpacks with 1 to 2 pound bags of sand--others added progressively), ponchos, full water bottles, helmets). This

TABLE 1 PHYSICAL TRAINING SCHEDULE

		Weeks							
		Cycle 1			Cycle 2		Cycle 3		Final Week
		<div>123</div>			<div>45</div>		<div>67</div>		8
Stamina (Aerobic Training)	Lower Body Dynamic Strength	PT Walk 30 min with pack, increase 1-2 lb/day up to 25 lb			Performed in running shoes with gradual use of boots beginning after the third week				
					ALTERNATE				
					Walk/run 30 min performed in running shoes				
Muscle Strength Development	Upper Body Dynamic Strength	Pull Ups (Timed) Wheelbarrow Race Rifle Exercises Load/unload AMMO Boxes or Sand Bags							
	Upper Body Static Strength	Isometric Rifle Exercises Log drills eg. Pivot Circle							
	Lower Body Static Strength	Log Drills eg. Half Knee Bends							
	Upper Body Explosive Strength	Log Drills eg. Overhead Toss Medicine Ball							
	Lower Body Explosive Strength	20 yd Shuttle Run 60 m Line Relay							
	Trunk Strength	Leg Lifts Leg Spreader Squst Thrust							

training activity more nearly approaches realistic scenarios that soldiers will be required to perform in combat. Such training should increase stamina, lower body dynamic strength, and trunk strength.

The implementation of this form of exercise should be made with the consideration of the principles described in their work (23). Several of the weight and distance tables presented in their work should also provide guidance for the development of weekly walking periods. Briefly, the PT walking period of 30 minutes should remain constant throughout IET. However, the speed should be increased during the first three weeks from approximately 2.5 to 3.5 mph as the troops adjust to the forced walking pace. Additionally, the weight load should be progressively increased by 1 to 2 lb/day. The initial weight load should be 2 to 3 lb with a final weight of approximately 25 lb.

It is suggested that during this initial period that the "PT walk" should be performed in the the same running shoes that will be used for the PT run performed during the later stages of IET. As the weight load increases, and the troops have worn their boots for one to two weeks, it may be necessary to use boots for the PT walk to provide adequate support of the ankles and feet.

Increased weight load can be easily achieved by each soldier preparing their back pack with the required sandbags the evening before the walk. Army back packs should be available in the inventory.

(b) All running during the first three weeks should be performed

in running shoes and the total distance run without stopping should not exceed approximately 200 m. The running during this period is intended to develop lower body explosive strength.

During the fourth week the PT Walk should be alternated with a 30 min run (in running shoes) using a walk/run approach. During the first week of running, more time will be spent walking than running; however, by the end of IET, this 30-min period should be comprised entirely of running.

(c) The remaining exercises contained in Table 1 are intended to increase dynamic, static, and explosive strength in both the upper and lower body. When performing the log exercises, care should be taken to follow the principles outlined in this report and in FM 21-20 concerning the gradual increase in work load to increase strength. Additionally, lighter logs should be used for all soldiers during the early part of IET and for female soldiers through out IET.

One important message contained in Table 1 is, since these critical performance factors represent those necessary to perform successfully the various tasks which comprise the most strenuous MOSs, they are the ones that must be trained. It is anticipated that such training will yield (1) increased strength following IET and (2) improved performance for these most physically demanding army jobs.

Further work may be necessary to provide additional exercises which can be used to develop each strength factor and to provide variety in the exercises to maintain interest. Many of these exercises require some equipment (e.g., logs, rifles) and thus are not

conducted with the same degree of ease as would be the more traditional pushups, situps, etc. However, in order for the body to increase each of the strength attributes, the proper stimulus must be present, and the more traditional methods do not provide that stimulus.

(d) In some cases, the cost for additional equipment can be reduced by the use of available material. Where ammo boxes are available, they can be filled with sand and a timed exercise of loading and unloading these boxes on a platform could be performed. Sandbags could also be used in such an exercise. Using such materials soldiers could participate in relay races lifting and placing (i.e., upper body static and dynamic strength and trunk strength) and carrying (lower body dynamic and static strength).

(e) To get local commanders to change and support these new physical training concepts requires the commander's full working knowledge of the underlying concepts which describe the performance of each MOS. Examples which describe each of these strength attributes should be presented. Allowances must be programmed into the schedule which will permit more time to perform the exercises requiring the use of specific equipment e.g., log exercises.

(f) The stretching exercises which are currently performed should be continued. For the purposes of the present report they were not discussed.

(g) Because overuse injuries typically appear during the first three weeks of PRT the frequency of training sessions and the

intensity and duration of work per week should be constant over the initial 3 weeks. According to the principles outlined, maintaining a constant intensity PRT program followed by a gradual increase will provide a base on which a PRT program can be built.

(h) Total physical training for the first 21 days should be cyclic with days 8 to 14 and 15 to 21 repeating the pattern established for days 1 to 7. The weekly cycle should incorporate 3 to 4 (maximum) training days of medium to long duration with corresponding medium to low intensity work rates. The recovery days should be evenly interspersed and should include short duration low intensity work. One day each week should be free of any physical training to allow recovery from possible overuse of the physiological or psychological systems.

(i) A newly designed boot incorporating a more cushioned midsole, a stiff shank, but flexible sole region at the forefoot-metatarsal junction should be worn when necessary. As an intermediate solution to the shock absorbancy problem a shock-absorbing heel pad (sorbothane) could be placed in the boots of the new recruits to reduce the shock transmitted through the lower extremities.

A high quality athletic or running shoe with similar qualities as the boot, but with a more cushioned sole and midsole, should be worn for physical fitness training and at recreation times. After the initial 3 week training period, the recruits should be adapted enough to wear the boot as part of the normal military uniform, except when training for many of the physical training exercises. An example of

possible exceptions would be the shuttle run conducted on uneven dirt of grass. During this exercise the combat boot would provide additional ankle support that is needed during the sudden stopping and starting.

4. The remaining 4-5 weeks of IET should be in 2-week progressive increments of either frequency, duration, or intensity, or their combinations. Each 2-week period should remain constant in terms of frequency of training sessions per week and duration and intensity of work per week with the exception of the PT Walk which is usually increased more frequently.

(a) Total physical training for each 14-day period should be cyclic, with days 8 to 14 repeating the pattern established for days 1 to 7. The weekly cycle should incorporate 4 training days of alternating medium or long duration with medium or low intensity work rates, respectively. The recovery days should be evenly interspersed, and should include days of short duration, low intensity work rates.

5. The nutritional requirements for recruits in physically exhausting training are similar to those in the civilian population. Several earlier studies (25-27) of Army mess practices and energy expenditure in recruit training indicate sufficient caloric intake. During physically exhausting periods of training the caloric intake should be mixed with approximately 30% fats (maximum), 10% protein, and 60% carbohydrate (minimum). Water and other fluids should be readily available to avoid heat or dehydration injury. With adequately balanced meals, dietary supplementation may be avoided.

Women in basic training or during other exhausting physical stress periods may require additional amounts of iron and calcium to prevent anemia and bone stress injuries. Additional amounts of iron and calcium should be obtained by consuming foods that are high in these substances, rather than by oral supplementation if possible (28, 29). Salt tablet supplementation is not recommended at any time by any recruit.

Food taken at regular mess intervals during routine training periods is optimal for performance. Intense or long duration physical training of any kind should follow meals by 2 or more hours to avoid gastric distress and provide optimal muscular blood flow and energy supply. The basic plan of "three square meals a day" may best serve extensive training with 2 light carbohydrate snack supplements each day. When field training is combined with extensive physical training, frequent intermittent feedings that are high in carbohydrate calories are required to postpone exhaustion (30).

Attempts to reduce percent body fat during initial entry training should be limited to 1 or 2 pounds per week. Greater losses will lead to severe levels of fatigue and increased susceptibility to stress injury (2,11).

6. Sleep and other recovery periods from physical training are essential for the optimal physical development of an initial-entry recruit. The development of the general physiological systems of the recruit is of primary importance during basic training. The sudden introduction of a physically stressful training cycle places a great

demand on the adaptive mechanisms of the body, including an increased demand for muscular activity energy, for the biochemicals and energy for growth and repair, and for organ system energy production. These demands require sleep and recovery time for digestion, circulation, and efficient utilization of the biochemical processes involved (31). During the initial-entry training period it is very important to establish regular periods of physical training, eating, resting, and sleeping, while the general physiological systems are adapting and being developed. During the initial 3 weeks of basic training a regular sleep pattern of 6 hours (minimum) should be established before irregular training, sleeping, or eating is introduced. Several studies of military training injuries (1,2,4,5) have confirmed that the highest incidences of overuse or stress injuries occur in the initial three weeks of training. The principles of training physiology and medicine provide the rationale for gradual progression in training during this critical initial three week period. The more gradual physical adaptation with reduced fatigue and injury will provide more efficient use of the initial 3-week training period without loss in present or future training time.

Consecutive days of physically demanding training with reduced or erratic sleep is detrimental to both improved development and fatigue-injury prevention. In addition to regular sleep cycles, other morning and afternoon periods of non-physical activity are necessary for the body's restorative powers to be invoked between physical training activities. These recovery periods can be placed conveniently between

class sessions and pre- or post-mess hours. Also, there should be a wait of 1 to 2 hours after eating before performing high intensity physical training. The periods of sleep and recovery are critical in determining both the quantity and quality of the recruit's physical training development. Excesses of intensity, duration, and frequency in physical training during the first three weeks of training with insufficient sleep and recovery periods make the recruit susceptible to overuse injury and illness.

SUMMARY

A systematic approach to the evaluation and modification of physical training in the 8 to 10 week U.S. Army basic training period has been attempted in order to provide optimal physical development with minimal injury to both male and female recruits. This report represents only a small part of the grand scheme not only to maintain the superior physical fitness attained by proper basic training, but to improve and maintain the physical fitness of all U.S. Army personnel throughout their careers and lives. Future studies and reports on physical fitness and the health of the Army may benefit from a similar rationale as used in this report.

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